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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 09/896,798
Filing Date: June 29, 2001
Appellant(s): LUO ET AL.

Justin D. Petruzzelli
For Appellant

**EXAMINER'S ANSWER**

This is in response to the appeal brief filed 30 October 2007 appealing from the Office action mailed 30 May 2007.

**(1) Real Party in Interest**

A statement identifying by name the real party in interest is contained in the brief.

**(2) Related Appeals and Interferences**

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

**(3) Status of Claims**

The statement of the status of claims contained in the brief is correct.

**(4) Status of Amendments After Final**

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

**(5) Summary of Claimed Subject Matter**

The summary of claimed subject matter contained in the brief is correct.

**(6) Grounds of Rejection to be Reviewed on Appeal**

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

**(7) Claims Appendix**

The copy of the appealed claims contained in the Appendix to the brief is correct.

**(8) Evidence Relied Upon**

| | | |
|---|---|---|
| 5,936,684 | MURAYAMA | 8-1999 |
| 5,649,025 | REVANKAR | 7-1997 |
| 6,501,566 | ISHIGURU ET AL. | 12-2002 |
| 4,945,478 | MERICKEL ET AL. | 7-1990 |
| 5,565,994 | ESCHBACH | 10-1996 |
| 5,621,546 | KLASSEN ET AL. | 4-1997 |

**(9) Grounds of Rejection**

The following ground(s) of rejection are applicable to the appealed claims:

**Claims 16 and 21-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama (US Patent 5,936,684) in view of Revankar (US Patent 5,649,025).**

**Regarding claim 16:** Murayama discloses a method (figure 10 of Murayama) for multitone processing an N level digital image to produce an M level digital image (figure 4 and column 9, lines 34-39 of Murayama) wherein M and N have unchanging values and M<N (e.g., M=4, N=256), comprising the steps of clustering all of the pixel values (figure 1(S1-S4) of Murayama) of the N level image into M (M<N) reconstruction levels (column 8, lines 23-32 of Murayama) based on the gray level distribution of the N level image (figures 2a-2b; figure 4; and column 9, lines 34-45 of Murayama), wherein the clustering produces K clusters of pixel values (figure 4 and column 8, lines 39-43 of Murayama), and wherein K=M (4 clusters (K) and M=4); and minimizing error between the N level digital image and the M level digital image during said clustering (figure 2b; column 8, lines 44-49; and column 10, lines 22-24 and equation 5 of Murayama). Said error is minimized as a part of the process of clustering. The even distribution of the threshold values based on the cumulative histogram (figure 2b and column 8, lines 44-49 of Murayama) and the maximization of the interclass variance (column 10, lines 22-24 and equation 5 of Murayama), which also distributes the threshold values as evenly as possible, minimizes the error between the N level digital image and the M level digital image during said clustering.

Murayama further discloses that the number of clusters K is set constant, and thus does not change (column 8, lines 37-43 of Murayama – *number of thresholds (which is one less than the number of clusters) is set based on the number of levels produced (M) which is unchanging*); and applying multilevel error diffusion (figure 1(S5) of Murayama) to the N level digital image using said M reconstruction levels to produce the M level digital image (column 14, lines 56-62 of Murayama). A part

of the n value conversion (figure 1(S5) of Murayama) is the application of multilevel error diffusion (column 14, lines 56-62 of Murayama).

Murayama further discloses applying said M level digital image to an image output device (figure 6("OUTPUT") and column 10, line 66 to column 11, line 2 of Murayama).

Murayama does not disclose expressly repeatedly revising said K clusters of said pixel values until error between the N level digital image and the M level digital image is minimized, wherein throughout the repeated revising of said K clusters, the number of clusters K does not change.

Revankar discloses repeatedly revising the threshold values (and thus K clusters *as per* the teachings of Murayama) of pixel values (figure 6(304,306) and column 6, lines 56-65 of Revankar) until a predetermined stopping condition is reached (column 6, line 64 to column 7, line 5 of Revankar).

Murayama and Revankar are combinable because they are from the same field of endeavor, namely digital image data threshold determination. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to perform the clustering taught by Murayama, iteratively and until a predetermined stopping condition is reached, as taught by Revankar, which would be the minimum error taught by Murayama. The error minimization taught by Murayama minimizes said error in terms of only one iteration of said clustering. With repeated iterations of said clustering, which would inherently occur after the first said clustering, said error would be minimized using the stopping condition criteria, as taught by Revankar. The motivation for doing so would have been that different portions, or segments, of an image can be better halftoned if multiple thresholds are applied to each region, rather than a single global thresholding (column 2, lines 25-31 of Revankar), and it would have been clear to one of ordinary skill in the art at the time of the invention that minimizing error in image document reproduction is desirable. Furthermore, Murayama teaches that the number of clusters K is set constant, and thus does not change, as discussed above. Thus, throughout the repeated revising of said K clusters (by iteratively performing the clustering taught by Murayama), the number of clusters K does not change. Therefore, it

would have been obvious to combine Revankar with Murayama to obtain the invention as specified in claim 16.

**Regarding claim 21:** Murayama discloses a method for multi-tone processing an N level digital image to produce an M level digital image (figure 4 and column 9, lines 34-39 of Murayama) wherein M and N have unchanging values and M<N (e.g., M=4, N=256), comprising the steps of: assigning pixels of the N level digital image to the M cluster centers to provide assigned pixels (column 8, lines 44-49 of Murayama); calculating values of said cluster centers based upon respective said assigned pixel (figure 4 and column 9, lines 34-45 of Murayama); selecting final values of said cluster centers as reconstruction levels (figure 4 and column 9, lines 34-39 of Murayama); applying multilevel error diffusion (column 14, lines 56-62 of Murayama) to the N level digital image using said reconstruction levels to produce the M level digital image (figures 8-9 and column 12, lines 58-62 of Murayama); and applying said M level digital image to an image output device (figure 6("OUTPUT") and column 10, line 66 to column 11, line 2 of Murayama).

Murayama does not disclose expressly setting initial values of M cluster centers; and repeating said assigning and said calculating until a predetermined stopping condition is reached and, thereby, final values of said cluster centers are defined.

Revankar discloses setting initial values of M thresholds (and thus M cluster centers *as per* the teachings of Murayama) (column 5, lines 6-9 of Revankar); and repeating the overall threshold operations (figure 6(304, 306) and column 6, lines 56-65 of Revankar) until a predetermined stopping condition is reached (column 7, lines 1-5 of Revankar) and, thereby, final values of said thresholds (and thus cluster centers *as per* the teachings of Murayama) are defined (column 7, lines 1-5 of Revankar).

Murayama and Revankar are combinable because they are from the same field of endeavor, namely digital image data threshold determination. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to iteratively perform the threshold determination, as taught

by Revankar, thus initially setting the value of the M cluster centers and repeating said assigning and calculating steps taught by Murayama until a predetermined stopping condition is reached, as taught by Revankar. This would also result in the calculating step taught by Murayama being a step of calculating *new* values, since initial values are already set according to the teachings of Revankar. The motivation for doing so would have been that different portions, or segments, of an image can be better halftoned if multiple thresholds are applied to each region, rather than a single global thresholding (column 2, lines 25-31 of Revankar). Therefore, it would have been obvious to combine Revankar with Murayama to obtain the invention as specified in claim 21.

**Regarding claim 22:** Murayama discloses that said assigning minimizes respective mean squared error (figure 5(S23) and column 10, lines 22-24 and equation 5 of Murayama). Maximizing the interclass variance (figure 5(S23) and column 10, lines 22-24 and equation 5 of Murayama), distributes the threshold values as evenly as possible. Since the equation for variance is based on the square of the difference between the respective classes (figure 5(23) and column 10, equation 5 of Murayama), the respective mean squared error is minimized.

**Regarding claim 23:** Murayama discloses that the stopping condition is a predetermined threshold (column 8, lines 23-29 of Murayama). After the [n-1]th threshold has been determined, the threshold determination is stopped (column 8, lines 23-29 of Murayama).

**<u>Claims 18 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama (US Patent 5,936,684) in view of Revankar (US Patent 5,649,025) and Ishiguro (US Patent 6,501,566 B1).</u>**

**Regarding claim 18:** Murayama in view of Revankar does not disclose expressly that the first and last levels of the M levels are predetermined, wherein the first level is zero and the last level is the maximum possible level.

Ishiguro discloses that the first and last levels of the M levels are predetermined, wherein the first level (S0) is zero and the last level (S3) is the maximum possible level (figure 7; column 7, lines 24-26; and column 8, lines 31-34 of Ishiguro).

Murayama in view of Revankar is combinable with Ishiguro because they are from the same field of endeavor, namely digital image binarization. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to preset the first level to zero and the last level to the maximum possible level, as taught by Ishiguro. The suggestion for doing so would have been that halftone text data, which has lot of dark pixel surrounded by light pixels, is a typical feature in images (column 2, lines 61-63 of Ishiguro). This produces the peaks at the low density end and high density end of the histogram, such as shown in figure 7 of Ishiguro. Thus, the first and last levels should be set to zero and the maximum possible level, respectively. Therefore, it would have been obvious to combine Ishiguro with Murayama in view of Revankar to obtain the invention as specified in claim 18.

**Regarding claim 24:** Murayama in view of Revankar does not disclose expressly that the first and last levels of the M levels are predetermined.

Ishiguro discloses that the first and last levels of the M levels are predetermined (figure 7; column 7, lines 24-26; and column 8, lines 31-34 of Ishiguro).

Murayama in view of Revankar is combinable with Ishiguro because they are from the same field of endeavor, namely digital image binarization. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to preset the first level to zero and the last level to the maximum possible level, as taught by Ishiguro. The suggestion for doing so would have been that halftone text data, which has lot of dark pixel surrounded by light pixels, is a common feature in images (column 2, lines 61-63 of Ishiguro). This produces the peaks at the low density end and high density end of the histogram, such as shown in figure 7 of Ishiguro. Thus, the first and last levels should be set to zero and the

maximum possible level, respectively. Therefore, it would have been obvious to combine Ishiguro with Murayama in view of Revankar to obtain the invention as specified in claim 24.

**Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama (US Patent 5,936,684) in view of Revankar (US Patent 5,649,025), Merickel (US Patent 4,945,478), and Eschbach (US Patent 5,565,994).**

**Regarding claim 19:** Murayama in view of Revankar does not disclose expressly that the N level digital image has multiple channels and K-means clustering and multi-level error diffusion are performed on each of the multiple channels independently.

Merickel discloses performing K-means clustering on a N level digital image (column 11, lines 26-31 and column 15, lines 9-16 of Merickel).

Murayama in view of Revankar is combinable with Merickel because they are from the same field of endeavor, namely the setting and manipulation of digital image levels to better show the image. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to perform a K-means clustering operation, as taught by Merickel, on the N level digital image taught by Murayama. The motivation for doing so would have been that applying a K-means clustering algorithm would optimize the cluster assignments for the pixels since, upon completion of the iterations, less than one percent of the pixels change cluster assignments (column 11, lines 50-55 of Merickel). Therefore, it would have been obvious to combine Merickel with Murayama in view of Revankar.

Murayama in view of Revankar and Merickel does not disclose expressly that the N level digital image has multiple channels and K-means clustering and multi-level error diffusion are performed on each of the multiple channels independently.

Eschbach discloses an N level digital image (column 4, lines 18-20 of Eschbach) which has multiple channels (column 4, lines 21-24 of Eschbach), wherein said multiple channels are processed independently (column 4, lines 23-25 of Eschbach).

Murayama in view of Revankar and Merickel is combinable with Eschbach because they are from the same field of endeavor, namely digital image data halftoning. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use multiple channel image data, as taught by Eschbach, upon which to perform K-means clustering taught by Merickel and the multi-level error diffusion taught by Murayama, with each channel being processed independently, as taught by Eschbach. The motivation for doing so would have been that independent (column 1, lines 32-35 of Eschbach), separated primary color channels are necessary for the production of digital color images (column 1, lines 24-31 of Eschbach). Therefore, it would have been obvious to combine Eschbach with Murayama in view of Revankar and Merickel to obtain the invention as specified in claim 19.

**Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama (US Patent 5,936,684) in view of Revankar (US Patent 5,649,025), Merickel (US Patent 4,945,478), Eschbach (US Patent 5,565,994), and Klassen (US Patent 5,621,546).**

**Regarding claim 20:** Murayama in view of Revankar does not disclose expressly that the N level digital image has multiple channels and K-means clustering and multi-level error diffusion are performed in multi-channel vector space.

Merickel discloses performing K-means clustering on a N level digital image (column 11, lines 26-31 and column 15, lines 9-16 of Merickel).

Murayama in view of Revankar is combinable with Merickel because they are from the same field of endeavor, namely the setting and manipulation of digital image levels to better show the image.

At the time of the invention, it would have been obvious to a person of ordinary skill in the art to perform a K-means clustering operation, as taught by Merickel, on the N level digital image taught by Murayama. The motivation for doing so would have been that applying a K-means clustering algorithm would optimize the cluster assignments for the pixels since, upon completion of the iterations, less than one percent of the pixels change cluster assignments (column 11, lines 50-55 of Merickel). Therefore, it would have been obvious to combine Merickel with Murayama in view of Revankar.

Murayama in view of Revankar and Merickel does not disclose expressly that the N level digital image has multiple channels and K-means clustering and multi-level error diffusion are performed in multi-channel vector space.

Eschbach discloses an N-level digital image (column 4, lines 18-20 of Eschbach) which has multiple channels (column 4, lines 21-24 of Eschbach).

Murayama in view of Revankar and Merickel is combinable with Eschbach because they are from the same field of endeavor, namely digital image data halftoning. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use multiple channel image data space, as taught by Eschbach, upon which to perform the K-means clustering taught by Merickel and the multi-level error diffusion taught by Murayama, with each channel being processed independently, as taught by Eschbach. The motivation for doing so would have been that independent (column 1, lines 32-35 of Eschbach), separated primary color channels are necessary for the production of digital color images (column 1, lines 24-31 of Eschbach). Therefore, it would have been obvious to combine Eschbach with Murayama in view of Revankar and Merickel.

Murayama in view of Revankar, Merickel and Eschbach does not disclose expressly that said multi-level error diffusion is specifically multi-level vector error diffusion.

Klassen discloses performing multi-level vector error diffusion (column 4, line 66 to column 5, line 3 of Klassen).

Murayama in view of Revankar, Merickel and Eschbach is combinable with Klassen because they are from the same field of endeavor, namely digital image data halftoning. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to specifically perform multi-level vector error diffusion, as taught by Klassen, as said multi-level error diffusion process. The motivation for doing so would have been to consider the effects of the interactions between dot patterns of different color components (column 3, lines 21-27 of Klassen). Therefore, it would have been obvious to combine Klassen with Murayama in view of Revankar, Merickel and Eschbach to obtain the invention as specified in claim 20.

**Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama (US Patent 5,936,684) in view of Revankar (US Patent 5,649,025) and Eschbach (US Patent 5,565,994).**

**Regarding claim 25:** Murayama in view of Revankar does not disclose expressly that the N level digital image has multiple channels and said setting, assigning, calculating, repeating, selecting and applying steps are performed independently on each of said multiple channels.

Eschbach discloses an N level digital image (column 4, lines 18-20 of Eschbach) which has multiple channels (column 4, lines 21-24 of Eschbach), wherein said multiple channels are processed independently (column 4, lines 23-25 of Eschbach).

Murayama in view of Revankar is combinable with Eschbach because they are from the same field of endeavor, namely digital image data halftoning. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use multiple channel image data, as taught by Eschbach, upon which to perform said setting, assigning, calculating, repeating, selecting and applying steps, as taught by Murayama, with each channel being processed independently, as taught by Eschbach. The motivation for doing so would have been that independent (column 1, lines 32-35 of Eschbach), separated

primary color channels are necessary for the production of digital color images (column 1, lines 24-31 of Eschbach). Therefore, it would have been obvious to combine Eschbach with Murayama in view of Revankar to obtain the invention as specified in claim 25.

**Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Murayama (US Patent 5,936,684) in view of Revankar (US Patent 5,649,025), Eschbach (US Patent 5,565,994), and Klassen (US Patent 5,621,546).**

**Regarding claim 26:** Murayama in view of Revankar does not disclose expressly that the N level digital image has multiple channels and said setting, assigning, calculating, repeating, selecting and applying steps are performed in multi-channel vector space.

Eschbach discloses an N-level digital image (column 4, lines 18-20 of Eschbach) which has multiple channels (column 4, lines 21-24 of Eschbach).

Murayama in view of Revankar is combinable with Eschbach because they are from the same field of endeavor, namely digital image data halftoning. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to use multiple channel image data space, as taught by Eschbach, upon which to perform said setting, assigning, calculating, repeating, selecting and applying steps, as taught by Murayama, with each channel being processed independently, as taught by Eschbach. The motivation for doing so would have been that independent (column 1, lines 32-35 of Eschbach), separated primary color channels are necessary for the production of digital color images (column 1, lines 24-31 of Eschbach). Therefore, it would have been obvious to combine Eschbach with Murayama in view of Revankar.

Murayama in view of Revankar and Eschbach does not disclose expressly that said multi-channel image space is specifically multi-channel vector space.

Klassen discloses performing multi-level vector error diffusion (column 4, line 66 to column 5, line 3 of Klassen).

Murayama in view of Revankar and Eschbach is combinable with Klassen because they are from the same field of endeavor, namely digital image data halftoning. At the time of the invention, it would have been obvious to a person of ordinary skill in the art to specifically perform multi-level vector error diffusion, as taught by Klassen, as said multi-level error diffusion process, thus making said multi-channel image space specifically a multi-channel vector space. The motivation for doing so would have been to consider the effects of the interactions between dot patterns of different color components (column 3, lines 21-27 of Klassen). Therefore, it would have been obvious to combine Klassen with Murayama in view of Revankar and Eschbach to obtain the invention as specified in claim 26.

**(10) Response to Argument**

**<u>Regarding page 9, line 2 to page 11, line 4 of Appeal Brief:</u>**

*Appellant argues* that Revankar teaches a changing number of clusters K (K=M), and not a constant number of clusters K, and thus the combination of Murayama and Revankar fails to teach that the number of clusters K does not change, as required by independent claims 16 and 21.

*Examiner replies* that it is the primary reference Murayama, and not Revankar, that is relied upon to teach that the number of clusters K does not change. In Murayama, the number of thresholds, and thus the number of clusters, is set based on a constant number of levels to be produced [see column 8, lines 37-43 of Murayama]. The K clusters are changed by changing the threshold values [see figure 2b and column 8, lines 44-49 of Murayama], not the number of clusters K.

Revankar is relied upon to teach repeatedly revising the threshold values of pixel values [see figure 6(304,306) and column 6, lines 56-65 of Revankar] until a predetermined stopping condition is reached [see column 6, line 64 to column 7, line 5 of Revankar]. Thus, by applying the teachings of Revankar to Murayama, the threshold values of the K clusters are changed in an iterative fashion until a predetermined stopping condition is reached. Any teaching with respect to modifying the *number* of clusters K that may exist in Revankar was not relied upon by Examiner in the final rejection. Examiner relied upon the teachings in Revankar with respect to iteratively determining threshold values. Thus, the combination of Murayama in view of Revankar, as set forth in the final rejection, does teach that the number of clusters K remains constant.

**Regarding page 11, line 6 to page 12, line 26 of Appeal Brief:**

Since independent claims 16 and 21 are shown to be fully taught by the prior art combination of Murayama in view of Revankar, the remaining dependent claims cannot therefore be considered allowable merely due to their respective dependencies from either claim 16 or claim 21.

**(11) Related Proceeding(s) Appendix**

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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